Program Association Table
- table id
- section syntax indicator
- section length
- transport stream id
- version number
- current next indicator
- section number
- last section number
- program number
- program map PID
- CRC 32
- PAT reserved bits

Program Map Table
- table id
- section syntax indicator
- section length
- transport stream id
- version number
- current next indicator
- section number
- last section number
- PCR PID
- program info length
- stream type
- elementary PID
- ES info length
- CRC 32
- PMT reserved bits

The following elements of ATSC Standard Annex C were tested in the bitstreams:

5.2 Registration Descriptor
- program identifier
- audio elementary stream identifier

5.3 Program Paradigm
- PCR PID
- Video PID
- Audio PID
- Data PID

5.4 Constraints on PSI
- maximum spacing of PAT and PMT
- alignment descriptors
- adaptation headers

5.5 PES Constraints
- PES flags
- Video PES constraints
- Audio stream id

5.7 Identifiers
- AC-3 stream type
- AC-3 descriptor

Video Syntax

The following elements of ISO 13818-2 were tested in the bitstreams:

- sequence header
- sequence extension
- group of pictures header
- picture header
- picture coding extension
  - picture_structure = 3
  - concealment_motion_vectors = 0
  - qscale_type = 1
  - intra_vlc_format = 1
  - alternate_scan = 0
- quant matrix extension
- slice syntax
- macroblock syntax
  - macroblock address increment
  - coded block pattern
  - dct type
  - field motion type
  - frame motion type
  - motion vectors
  - macroblock types

    <u>I pictures</u>
    intra

    <u>P pictures</u>
    MC, coded
    No MC, coded
    MC, not coded
    Intra
    MC, coded, quant
    No MC, coded, quant
    Intra, quant

    <u>B pictures</u>
    Interp, not coded
    Interp, coded
    Bwd, coded
    Fwd, coded
    Intra
    Interp, coded, quant
    Bwd, coded, quant
- block syntax

The following elements of ATSC Standard Annex A were tested in the bitstreams:

5.1 Constraints with respect to MPEG-2 MP@HL
- sequence header constraints
- sequence extension constraints
- picture header constraints

Bitstream Compliance

Unless detailed below there were no compliance violations detected in the sampled bitstreams for the syntax elements in the above list. However, not all options of the above element were exercised. Specifically, coded video for formats other than 720 Progressive at 59.94 Hz frame rate and 1080 Interlace at 29.97 Hz frame rate was not available for verification.

Audio Elementary Stream Buffer:

The buffer required for audio decoding was not within the constraints of the ATSC Standard. The audio packets arrived in the transport stream approximately 0.42 seconds ahead of when they were to be decoded. This translates into a buffer requirement of about 22,000 bytes rather than the 2336 bytes as specified in Annex A of ATSC Standard A/52 Digital Audio Compression. This error is probably an encoding problem created by improperly equalizing delay between the video encoder and the audio encoder before the transport multiplexor.

Program Association Table:

- The **CRC_32** does not check correctly for the program association table.
- The maximum spacing constraint from the ATSC Standard of 100 msec is occasionally violated.

Program Map Table:

- The **CRC_32** does not check correctly for the program map table.
- The maximum spacing constraint from the ATSC Standard of 400 msec is occasionally violated.
- The usage of the **program_info_length** field in the table appears to be incorrect. This field should specify the length in bytes of any program descriptors which immediately follow it. However, it is coded with a non-zero value although zero bytes of program descriptors follow it. It appears to be interpreted as specifying the length of the elementary stream data which follows. This interpretation makes it ambiguous whether the data which follows **program_info_length** should be decoded as descriptor data or elementary stream data.
- The stream type of the AC-3 stream is identified as 0x06 rather than the value of 0x81 specified by the ATSC Standard
- The stream type of the data stream is identified as 0x48 which is an ISO reserved stream type and should not be used by applications. The stream should be assigned in the space 0x80 to 0xAF.

Program Paradigm:

- The data included in the bitstream is not correctly identified by the DATA PID as specified by the program paradigm. In all the bitstreams the base PID is 48 and thus the data should be carried in the base PID + 10 or 58, however, it is identified in the program map table as PID 60.

Descriptors:

- No descriptors are carried in the bitstream.
- According to the ATSC Standard a registration descriptor should be included in the program map table in program descriptors and audio elementary stream descriptors.
- The AC-3 descriptor is not included in the audio elementary stream descriptors as required by the ATSC Standard.

PES Headers:

- PTS and DTS values appear to be offset by at least 1 LSB. Since the DTS is equal to the PTS unless explicitly specified this means that the decoding time between two frames is not uniform, but depends on whether a DTS is present in the PES header of either picture. According to MPEG the exact DTS values for all pictures can be computed from the first DTS in a sequence, the frame rate, and frame pull-down flags. For example, for a 29.97 Hz frame rate the DTSs should increment by exactly 3003 for each frame. The encoded DTS values vary from the correct values by as much as ±2.5 LSBs.

Packet Continuity Counter:

- The packet continuity counter was discontinuous in one instance for the data elementary stream packets. Since the data contained repetition of a single ascii character it was not possible to determine if a packet was lost or the packet header incorrectly generated.

Start Code Zero Padding:

- In the video syntax any start code may be preceded by an unlimited number of 0 bits as a method of stuffing data. The Grand Alliance appears to use this feature for stuffing data before picture start codes, however, non-zero bits have been detected in the stuffing bits. The stuffing of non-zero bits create start code emulation in the video bitstream.

Compliance Test Conclusions

The audio buffering problem is a serious compliance violation that would prevent a decoder, which is correctly designed to the ATSC standard, from presenting audio. However, the nature of the compliance violation is such that it does not impact tested audio or video performance. To insure interoperability the buffer problem must be corrected by equalizing audio and video encoder latency.

The sample bitstreams contained other minor semantic violations and minor violations of the ATSC Standard requirements. Although some of the violations might prove troublesome to acquisition and decoding for some receiver designs, the detected errors do not represent any impairment in picture quality or coverage.

The Grand Alliance hardware should be brought into compliance with the ATSC Standard to prevent the promulgation of non-compliant bitstreams.

9.4. Transport Layer Interoperability

9.4.1. Bitstream Capture for MPEG Compliance Verification

The results of this test are included in *Section 9.3*, above.

9.4.2. Interoperability with ATM Networks

Responsibility for this test was assumed by the ATV Field Test Project. Refer to Field Test Report (*Part VII*) for details.

9.4.3. Multiple Ancillary Data Services

In accordance with *Section I-9.4.3* of the Test Plan, the Grand Alliance hardware was reconfigured to carry four data channels. Two of the channels (designated "Video" and "Aux 3" in the table below) carried a rate of roughly one-fourth the net channel rate. One of the channels ("Aux 1") was set to roughly 1 Mbps higher than one-fourth the net channel rate. The remaining channel ("Aux 2") was set to roughly 1 Mbps lower than one-fourth the net channel rate. The transmission channel was unimpaired, and a Strong (-28 dBm) level signal was presented to the receiver.

Each channel, in turn, was selected for output from the decoder. The data rate and the error-free performance of each channel were verified as shown in the table below.

Multiple Channel Ancillary Data

Channel	Data Rate (Mbps)	Bit Error Rate
Video	4.738	0
Aux 1	5.744	0
Aux 2	3.747	0
Aux 3	4.717	0

Section 10.

AUDIO/VIDEO/CAPTIONING LATENCY

10.1. Introduction

The latency (the delay between the input and output) of the Grand Alliance system—for video, audio, and captioning—was measured according to the procedures of *Section I-10* of the Test Plan. Details of the setups and methods used and the data obtained for each measurement are provided in the paragraphs that follow.

In the 1080I format, the audio was found to lag the video by 9-13 msec, varying by channel in the 5.1-channel audio configuration. The captioning was found to lead the 1080I video by 17-33 msec (*i.e.*, by one or two fields), depending upon whether the captioning was presented to the encoder on Field One or Field Two.

In the 720P format, the audio was found to lead the video by 36-40 msec, varying by channel in the 5.1-channel audio configuration. The captioning latency matched the video latency, leading the video by only one millsecond.

10.2. Video Latency

Video latency through the Grand Alliance system was measured in the following manner. A slowly moving zone plate test pattern was applied to the active video gate, which gated the pattern on and off coincident with vertical intervals. The gated video was applied to the Grand Alliance encoder. The trigger output of the gate, coincident with the video transition, was connected to Channel A of an HP 5316B Universal Counter. The output from the Grand Alliance Decoder was connected to Channel B of the HP 5316B. The counter was set up to measure the difference in time between the first transition on Channel A and the first transition on Channel B.

Table 10-1

Video Latency

	Latency (ms)
Video Latency - 1080I	846
Video Latency - 720P	813

10.3. Audio Latency

With reference to Figure 10-1, audio latency through the Grand Alliance system was measured in the following manner. Bursts of 1 kHz tone were generated using an Audio Precision System One sine wave generator triggered by a pulse from an active video gate which was coincident with the video transition. Analog sine wave bursts were employed because the digital audio generator of the System One cannot be triggered with an external signal. The 1-kHz tone bursts were converted to the digital domain using the A/D converters of a Sony HDD-1000 DVTR, and input to the Grand Alliance audio system. After passing through the Grand Alliance system, the tone bursts were converted back to the analog domain using the D/A converters of a Sony HDD-1000 DVTR.

The tone burst trigger signal was connected to Channel A of an HP 5316B Universal Counter, and the tone burst recovered from the Grand Alliance system output and converted to the analog domain was connected to Channel B of the counter. This facilitated precise measurement of the time interval between the start of a single burst and the arrival of that burst at the Channel B input of the counter, after traveling through the Grand Alliance system. The measurement was made in the analog domain because a definitive waveform edge, required to trigger the counter, could not be acquired from the AES/EBU digital audio data stream.

Grand Alliance audio system latency was tested both in 5.1 channel and in 2 channel modes. In the 5.1 channel mode, left, right, center, left surround, and right surround channels were tested. The subwoofer channel was not tested, because a sine wave frequency sufficiently high to possess a useful triggering slope cannot be passed through the subwoofer channel. It was determined that the combination of the latency between the trigger signal and the start of the tone burst, and the latency introduced by the A/D and D/A conversion of the audio signals, is negligible with respect to the audio latency through the Grand Alliance system, and could therefore be ignored.

Table 10-2

Audio Latency

		Ch.	Latency (ms)
Audio Latency - 2 ch.	1080I	1	855
" "		2	855
Audio Latency - 5.1 ch. †	1080I	1	855
" "		2	855
" "		3	857
" "		5	859
" "		6	858
Audio Latency - 2 ch.	720P	1	773
"		2	773
Audio Latency - 5.1 ch. †	720P	1	773
" "		2	774
" "		3	775
" "		5	777
" "		6	777

† Channel 4 (sub-woofer) not tested.

10.4. Captioning Latency

With reference to Figure 10-2, captioning latency through the Grand Alliance system was measured in the following manner. Triggered by a pulse from the active video gate which was coincident with the video transition, a 9600 bit/second ASCII "U" was generated by an SRS DS345 function generator set to burst 5 square cycles at 4800 Hz. This ASCII "U" was connected to Channel A of an HP 5316B Universal Counter and to the Grand Alliance encoder through a TTL/RS232 level converter. The output from the Grand Alliance decoder was connected to Channel B of the HP 5316B. The counter was set up to measure the difference in time between the first transition on Channel A and the first transition on Channel B. The latency through the TTL/RS232 level converter was measured in a similar fashion and was found to be insignificant (<1 mS).

Table 10-3

Captioning Latency

	Latency (ms)
Captioning Latency - 1080I	829/813*
Captioning Latency - 720P	812

* Latency depends on whether captioning is presented to the encoder on Field One or Field Two.

AUDIO LATENCY SETUP

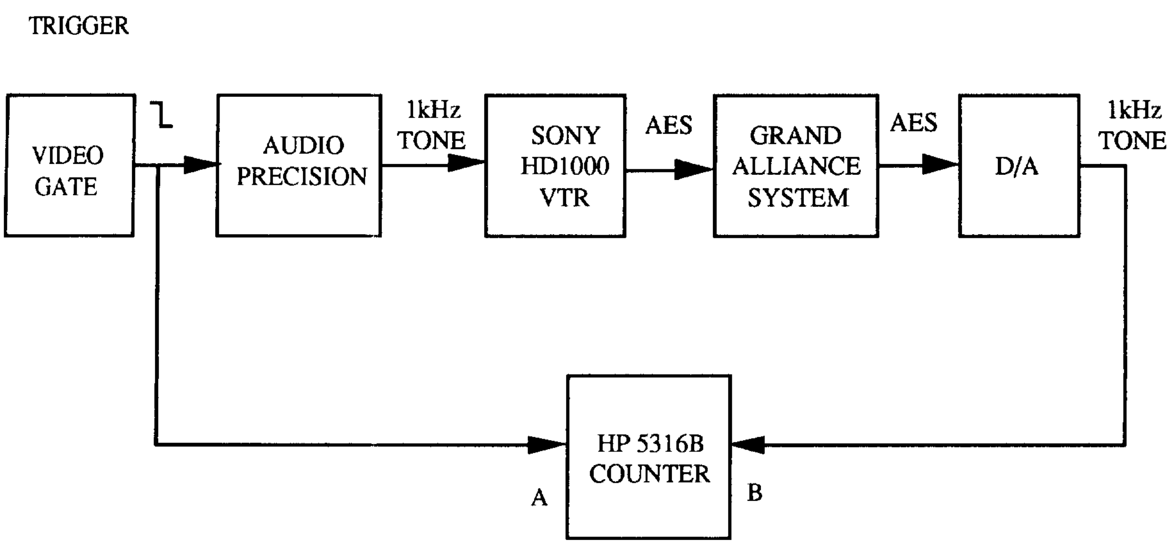

Figure 10-1

CAPTIONING LATENCY SETUP

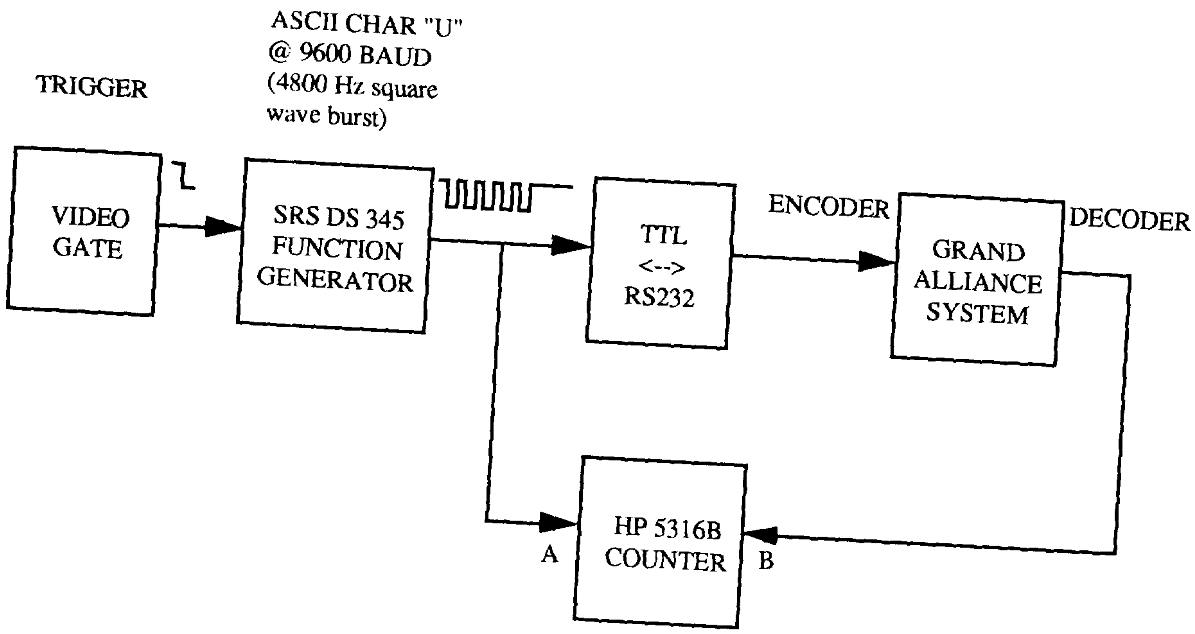

Figure 10-2

Section 11.

EFFECTS OF CONCATENATION ON AUDIO PROCESSING

11.1 Introduction

The purpose of these tests was to assess subjectively the performance of the Dolby AC-3 audio encoding/decoding system under several conditions of concatenation.

Source audio for all tests was three, 5.1 channel audio segments as specified in the Test Plan. For the duration of each test, the motion video image Reflections, M51, was continuously passed through the Grand Alliance system. During all tests, the Grand Alliance passed through the RF test bed in the strong and unimpaired mode.

11.2 Test Setup

Three test setups were used per the Test Plan. Test Setup 1 produced three versions of the audio segments: source, one pass through the system, and two passes through the system. The level reduction and voice-over mixing operations required by Test Setups 2 and 3 were achieved in the digital domain by using a digital audio workstation. Audio I/O interface to the Grand Alliance system was via HDD-1000 DVTR. To facilitate getting the audio segments into and out of the digital audio workstation, intermediate transfer was made to and from Alesis ADAT recordings. Test Setup 2 yielded two more versions of the audio segments: voice over with music reduced in level by 6 dB after one pass through the system, and voice over with music reduced in level by 6 dB which has passed through the system twice. Test Setup 3 generated another two versions of the audio segments: voice over with music reduced in level by 10 dB after one pass through the system, and voice over with music reduced in level by 10 dB which has passed through the system twice.

The audio material was presented to three expert listeners in the ATTC Viewing Room, the same room used for the evaluation activities of the Digital Specific Task Force. The sonic characteristics of the Viewing Room are approximately equal to or a little better than those of a typical living room environment. Presentation was made using a Macintosh C39 Audio Control Center configured to pass six discrete input signals (left, right, center, subwoofer, left surround and right surround), a B&K AV-6000, six-channel audio power amplifier, five Video Acoustics VA-1400 loudspeakers and a Video Acoustics subwoofer. The loudspeakers and listeners' chairs were arranged for 3/2 surround sound listening as specified in SMPTE Proposed Recommended Practice #173, which in turn conforms to the relevant ITU-R standard.

11.3 Measurement Technique

For Test Setup 1 above, the source audio was compared to that from the first pass through the Grand Alliance system, and the source audio was compared to that from the second pass through the system. For Test Setups 2 and 3 above, the first pass audio with added voice over (V.O.) was compared to the second pass audio with added voice over, for each music reduction level. There were a total of seven conditions:

1. Source audio	4. V.O. -6 first pass	7. V.O. -10 second pass
2. First pass through system	5. V.O. -6 second pass	
3. Second pass through system	6. V.O. -10 first pass	

The audio segments were organized into randomized paired comparison trials for presentation to three expert listeners. Each trial consisted of two presentations, one of which was a *Reference* segment and the other of which was a *Test* segment. For Test Setup 1, the *Reference* was the source audio segment, and the *Test* was a segment which had passed either once or twice through the system; *e.g.*, Berlioz Source vs. Berlioz 1 Pass, or Infinito Source vs. Infinito 2 Passes. For Test Setups 2 and 3, the *Reference* was the segment which had passed once through the system, and the *Test* was the corresponding segment which had passed twice through the system. For each of the seven conditions, trials were prepared which compared *Reference/Test*, *Test/Reference*, and *Reference/Reference*. This produced a total of 33 trials, which were recorded on the presentation tape in a pseudo-random order.

Each trial was recorded on the presentation tape twice, and the expert listeners were instructed to simply listen to the trial the first time it played, then make their evaluation the second time it played. Trials were freely repeated upon request of the expert listeners. Listeners were instructed to mark their judgment of the quality of each presentation by placing a horizontal line on a 10 cm scale conforming to ITU-R Rec. 500, a continuous scale which is divided into five quality levels ranging from "Excellent" at the top to "Poor" at the bottom. Paired comparison using a continuous rating scale was used rather than the expert observation and commentary specified in the test plan because it was felt that this more rigorous test would provide more accurate results .

11.4 Analysis of Results

Marks made on the rating scale for each presentation were measured and normalized to a 100-point scale. The lowest rating received by any presentation was 50, the highest 96. For each listener's rating of each pair, the *Reference* score was subtracted from the *Test* score. The mean *Test* minus *Reference* rating for each pair is plotted on the accompanying graph (Figure 11-1). For the *Reference/Reference* pairs, the second *Reference* score was subtracted from the first. The diamond in the graph represents the mean *Test* minus *Reference* rating, while the vertical lines above and below each diamond represent the 95% confidence interval. The following abbreviations apply to the sequence labels: S=Source, 1=1 pass through the system, 2=2 passes through the system.

The total number of trials rated by all expert listeners is 116. In 21 instances, the *Test* segment received a <u>lower</u> rating than the *Reference* segment. In 21 instances, the *Test* segment received a <u>higher</u> rating than the *Reference* segment. In 42 instances, the *Test* and *Reference* segments received equal ratings. For the *Reference/Reference* trials, in 17 instances the two *Reference* segments received equal quality ratings, while in 15 instances, the two *Reference* segments received different quality ratings. Each of these categories contains a random mix of music and voice-over segments, indicating that no particular condition or type of music fares better or worse than any other.

11.5 Conclusion

The Test Center concluded that the expert listeners could not reliably discriminate between *Reference* and *Test* segments, and that under the conditions of concatenation and voice-over addition tested, the Grand Alliance audio system causes no substantial degradation in audio quality.

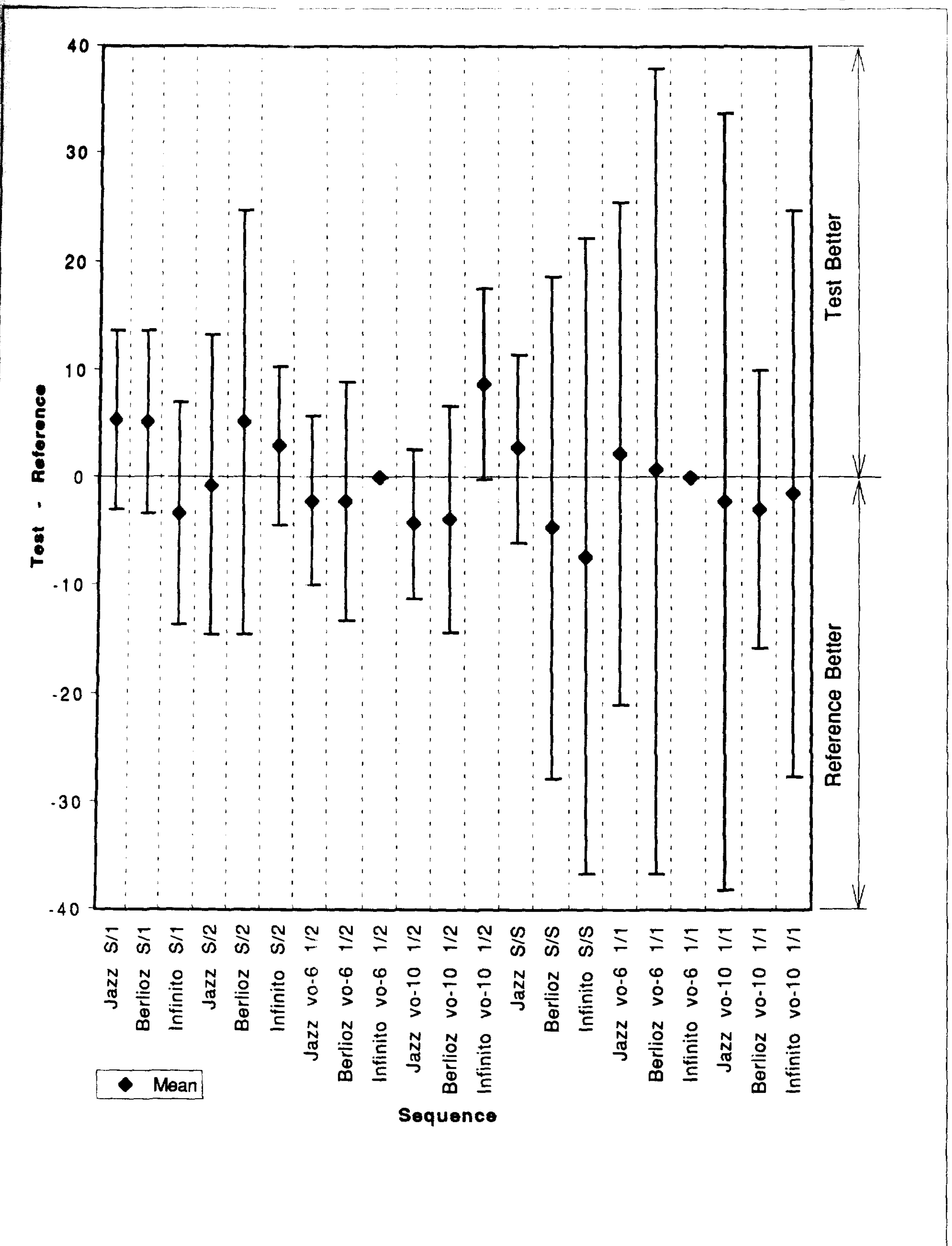
Test - Reference
40
30
20
10
0
-10
-20
-30
-40
Test Better
Reference Better
Jazz S/1
Berlioz S/1
Infinito S/1
Jazz S/2
Berlioz S/2
Infinito S/2
Jazz vo-6 1/2
Berlioz vo-6 1/2
Infinito vo-6 1/2
Jazz vo-10 1/2
Berlioz vo-10 1/2
Infinito vo-10 1/2
Jazz S/S
Berlioz S/S
Infinito S/S
Jazz vo-6 1/1
Berlioz vo-6 1/1
Infinito vo-6 1/1
Jazz vo-10 1/1
Berlioz vo-10 1/1
Infinito vo-10 1/1
Mean
Sequence

Figure 11-1

Section 12.

TESTS CONDUCTED BY ATTC ON BEHALF OF THE TASK FORCE ON DIGITAL-SPECIFIC TESTING

12.1. Introduction

Two of the tests specified in *Part II* of the Grand Alliance System Test Procedures, "Tests to be Conducted by the Task Force on Digital-Specific Testing", were in fact conducted by ATTC on behalf of the Task Force, in the interest of efficiency.

The first of these was the test of Multiple Impairments: Noise and Co-channel NTSC into ATV (Test Plan *Section II-2.6*). The Test Plan anticipated that the Task Force would use the visual subjective method to determine the TOVs, as they had in the first round of testing on the four original digital ATV systems. However, the BER method had been used successfully in the transmission subsystem "bakeoff" between the 8-VSB and 32-QAM modems. Therefore, at the request of the Grand Alliance, and with the consent of the Chairman of the Task Force and the Chairman of SS/WP-2, it was agreed to use the BER TOV method for testing the Grand Alliance system.

The other test conducted by ATTC for the Task Force was the test of Video Quality/ Auxiliary Data Tradeoff - Opportunistic Data Capability (Test Plan *Section II-2.11*). The opportunistic data rates were measured by ATTC, and a recording was made of the video and audio that were transmitted simultaneously with the data through the Grand Alliance system. Members of the Task Force on Digital-Specific Testing viewed and listened to the recording to confirm that there was no tradeoff of quality in this opportunistic data mode.

12.2. Multiple Impairments: Noise and Co-channel NTSC into ATV

The test was conducted in accordance with the step-by-step procedure described in *Section II-2.6* of the Test Plan, except that the BER TOV method was used. The results are tabulated in Table 12 1 and presented graphically in Figure 12-1.

Table 12-1

Multiple Impairment: Co-channel + Noise
Conditions that Maintain TOV

Desired Level = Strong (-28.01 dBm actual)

Signal-to-Noise (dB)	Desired-to-Undesired Ratio (dB) for Co-Channel NTSC
15.35	no noise
16.35	19.94
17.35	17.69
18.35	16.44
19.35	7.19
20.35	4.69
21.35	3.69
22.35	2.94
23.35	2.44
no co-channel	1.19

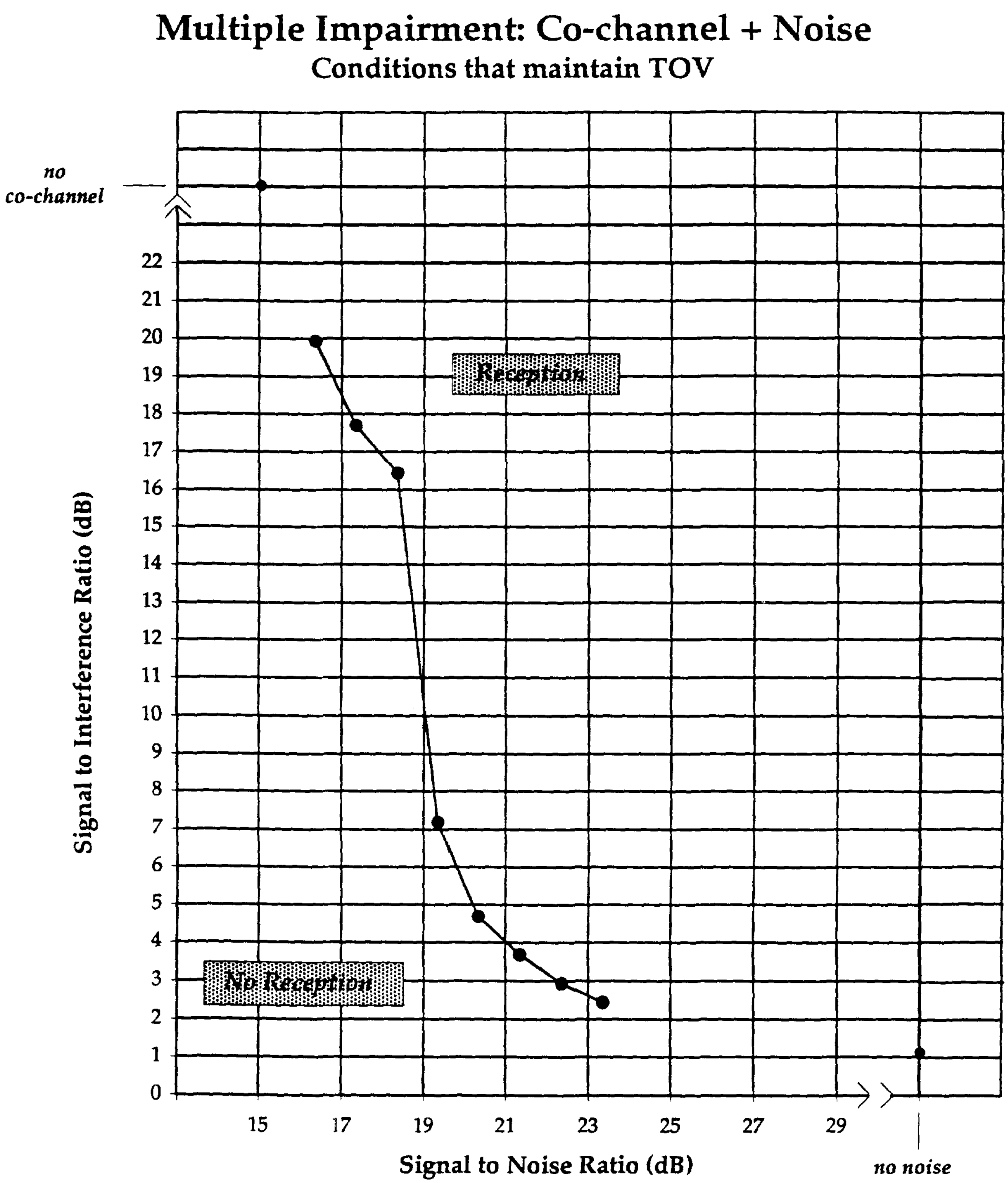
Multiple Impairment: Co-channel + Noise
Conditions that maintain TOV
no co-channel
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Reception
No Reception
Signal to Interference Ratio (dB)
15
17
19
21
23
25
27
29
no noise
Signal to Noise Ratio (dB)

Figure 12-1

12.3. Video Quality/Auxiliary Data Tradeoff- Opportunistic Data Capability

The Transport Encoder of the Grand Alliance system was operated in its normal configuration for this test, with auxiliary data having a lower priority than the video. A complete description of this configuration, as well as the configuration used for the companion tradeoff test at constant (forced) data rates, may be found in a letter from R. Bunting (GA) to T. Gurley (ATTC) of 7/21/95, which is reproduced in *Section 14*.

Special interface hardware was built by ATTC to reset, start, and stop a digital panel meter ("bit-ometer") integral to the Grand Alliance decoder. The function of this counter is to count the packets (in thousands) being received via the auxiliary data channel. A Cipher Digital CDI 750 time code reader was used to track the time code of the video being played back into the Grand Alliance encoder and to trigger the counter. Three different 10-second clips of video ("Dream Team", "Snow Trees", and "Lamp") were played through the Grand Alliance system. Due to the latency through the system an offset to the time codes was necessary.

Opportunistic data through the Grand Alliance system was measured in the following manner. An operator actuated a push-button resetting the Grand Alliance counter to zero. A Sony HDD-1000 DVTR played a 10-second video clip and sent time code to the CDI 750 simultaneously. The CDI 750, on receiving an appropriate time code, sent a trigger to the Grand Alliance counter to start it counting packets, and 10 seconds later to stop counting. The latency was accounted for by successive approximation until only the video of interest was framed by the time code triggers. Since the video was framed by black, and black video allows for a maximum of auxiliary data, the method used to eliminate the effects of latency through the system was to adjust the start time code—with the stop time code being 10 seconds later—for a minimum of data. This process was repeated three times for each of the three video clips. Additionally, three cumulative samples were taken of the three-clip sequence, including intermediate blacks of 1 second each.

The results of the measurements are presented in Table 12-2. In preparing the table, the packet count was divided by the image duration to express the opportunistic auxiliary data rate in Mbps.

Table 12-2

Opportunistic Data

Image		Run	Count (Mbps)
Dream Team	10 sec	1	0.11673
		2	0.12102
		3	0.11630
		AVERAGE	**0.118**
Snow Trees	10 sec	1	0.11379
		2	0.11498
		3	0.11586
		AVERAGE	**0.115**
Lamp	10 sec	1	0.22243
		2	0.22331
		3	0.21788
		AVERAGE	**0.221**
Dream Team	10 sec	1	1.12191
Black	1 sec	2	1.12306
Snow Trees	10 sec	3	1.11348
Black	1 sec	AVERAGE	**1.119**
Lamp	10 sec		

Section 13.

PREPARATION OF VIDEO AND AUDIO RECORDINGS FOR OFFSITE TESTING

13.1. Introduction

Video tapes were prepared by ATTC for ATV quality assessment and for NTSC impairment assessment at the Advanced Television Evaluation Laboratory (ATEL) in Ottawa, Canada. Video/audio recordings were made of the "Long Form Entertainment Program" for off-site assessment.

On a number of occasions, difficulties were encountered in obtaining error-free video and/or audio recordings through the Grand Alliance system. Further details on this issue may be found in *Section 14*, along with documentation from the Grand Alliance on action taken to partially alleviate these problems.

13.2. Video Impairment Rating Tapes

Video impairment rating tapes were made according to the Video Subjective Test Procedures (*Part III* of the Test Plan), using the test and demonstration images specified in *Appendix 2* of those Procedures. These tapes were made using the same two random orders used in the first round of testing. The Undesired levels on the tapes include those determined by the expert observers during the ranging procedures covered in *Section 3*. In addition to these levels, which are found in the respective tables of *Section 3*, recordings were made at an additional sub-threshold level (2 dB below Threshold of Visibility). The "impaired" signal levels are shown in Table 13-1.

As discussed fully in *Section 3.7.3*, rating tapes were also produced for upper-adjacent channel ATV-into-NTSC interference. However, based upon subsequent analysis of the results of the expert viewing, the ranging levels were declared invalid by the Chairman of SS/WP-2. Therefore, those levels do not appear in Table 13-1.

Table 13-1

SIGNAL LEVELS APPEARING ON NTSC VIDEO SUBJECTIVE RATING TAPES

			UNDESIRED LEVEL (dBm) (Per PS/WP-6 Randomization)						
			1	2	3	4	5	6	
TEST	ATTC TEST #	DESIRED LEVEL	(SUB TOV)	TOV	TOV+1	TOV+2	TOV+3	TOV+4	POU (NOT ON TAPE)
LO-A/N	9	W	-51.08	-49.08	-43.14	-38.89	-34.89	-31.89	-28.91
LO-A/N	9	M	-36.23	-34.23	-24.39	-22.39	-20.64	-18.77	-14.91
CO-A/N	16	W	-104.74	-102.74	-97.01	-90.26	-85.51	-79.80	-71.07

13.3. Video Basic Received Quality Rating Tapes

Video quality rating tapes, consisting of reference cuts in the 1035I format and test cuts recorded through the Grand Alliance system, were made according to the Video Subjective Test Procedures (*Part III* of the Test Plan), using two random orders. The tapes contain 26 test images, comprising 6 stills and 20 motion sequences.

Two sets of tapes were furnished to ATEL, one set using the 720P mode of the Grand Alliance system and one set using the "alternate 1080I" mode, in which the system repeats the top 45 lines of the 1035I source material to fill the top of the 1080I active picture. In each mode, a "Quality Master" tape was recorded by playing a "Format Master," containing all of the stills and motion sequences, through the Grand Alliance system. The RF Test Bed was set to provide a Strong (-28 dBm) level, unimpaired signal to the receiver.

In reviewing the completed quality rating tapes, ATTC and ATEL determined that there were color discrepancies in the six PIXAR-originated still images between the 1080I and 720P modes. The color of these sequences, for both Reference and Test cuts, was shifted slightly toward red for 1080I relative to 720P. The 720P sequences matched those of the "core" sequences common to the first round of testing. In the opinion of ATEL and ATTC staff, the magnitude of the color shift was small enough as to have no important effects on the performance of the Grand Alliance system, nor to preclude comparison of results from the current round of testing with those from the first round. Further information on this matter may be found in Doc. SSWP2-1465, which is reproduced in *Section 14*.

13.4. Receiver Scan Conversion Quality Rating Tapes

The Task Force on Digital-Specific Testing selected eight scan-converted images to be sent to ATEL for non-expert subjective evaluation. In addition, three images were used for demonstration purposes. These scan-converted images were sent to ATEL in two random orders, to be evaluated in the same manner as basic received quality.

The images are listed in Table 13-2.

Table 13-2

Image #	Still/ Motion	Description	Quality To ATEL
S7	S	Fruit & Vegetables	Demo
S10	S	Memorial Arch	Demo
M42	M	Roller Coaster #1	Demo
S1	S	Metal Table & Chairs	
S14A	S	Cheshire Cat	
M6	M	Den	
M10	M	Woman & Room	
M16A	M	Rotating Pyramids	*
M40	M	Dream Team	
M43	M	Advisory Committee (Ducks)	
M49	M	Picnic with Ants (Still w Noise)	*

* All image cuts were 10 seconds in length. As in other subjective quality tests, the center 10 seconds from an original 15-second image was used for all images except the two images asterisked. Alternate cuts were used for these two images. Picnic with Ants used the last ten seconds. Rotating Pyramids used the 10 seconds ending with the last frame of scrolling text.

Note: The camera-generated test materials which were used for non-expert subjective assessment of the basic quality performance of the Grand Alliance system, in the 720P format, had been captured in the 1035-line (active) interlaced format and scan converted to the 720P format for input to the system. The artifacts from the interlaced capture process were carried over in this scan conversion process. Therefore, the scenes viewed in the progressive-scan format showed such artifacts in addition to the expected spatial resolution reduction from 1035 to 720 active lines, and from 1920 pixels/line to 1280 pixels/line. The same carry over of artifacts occurred in the tests of receiver scan conversion, which were conducted by the Task Force on Digital-Specific Testing and from which some material was selected for non-expert subjective assessment. In these tests, the material was applied to the encoder and transmitted in the interlaced format and converted to progressive scan in the receiver.

13.5. Long-Form Entertainment Program

Two videotapes were recorded through the Grand Alliance system for viewing by expert observers at a later time The procedure is described in *Section III-8* of the Test Plan. Two source tapes, in the 1035I format, were furnished to ATTC by PS/WP-6. One of the tapes is a compilation of various video and film-originated pieces, with accompanying stereo audio. It is approximately 45 minutes in length. The other tape consists of excerpts from a theatrical motion picture, "The Hunt for Red October," with accompanying 5.1-channel audio. This tape is approximately 25 minutes long. Both tapes were fed through the Grand Alliance system operating in the "alternate 1080I" mode. The RF Test Bed was set to provide a Strong (-28 dBm) level, unimpaired signal to the receiver.

The compilation tape was recorded with no errors. In the "Red October" recording, however, there were two "hits" that affected both video and audio. The duration of each hit was approximately 3-4 frames. Both were observed at the output of the Grand Alliance system during recording but the effects of both were magnified by the recording process.

The comments received from the expert observers during the offsite viewing sessions may be found in *Section I-14*

Section 14.

ADDITIONAL DATA & OTHER INFORMATION

Included in this Section are:

- Certifications by the Grand Alliance to Advanced Television Test Center
- Example of NTSC Voting Analysis
- Receiver-by-Receiver Tabulations of NTSC TOV, CCIR3/CCIR4, and POU Voting
- Bit Error Rate Data for ATV Interference/Impairment Tests
- Analysis by ATTC Chief Scientist of Color Beat from Upper-Adjacent Channel ATV-into-NTSC Interference
- Correspondence and Other Documents
    - SSWP2-1432, Letter from C. Rhodes (ATTC) to M. Richer (Chairman, SS/WP-2), dated May 16, 1995, describing change in the Test Plan for certain co-channel interference tests.
    - Letter from William O'Grady (Philips) to C. Rhodes (ATTC) regarding difficulty experienced in recording the decoder and scan converter outputs, dated July 20, 1995.
    - SSWP2-1456, Letter from T. Smith (Sarnoff) to M. Richer (Chairman, SS/WP-2), dated July 18, 1995, discussing difference (*i.e.* sync level) between Grand Alliance prototype hardware and system approved by Technical Subgroup.
    - R. Bunting (Sarnoff) explanation, dated July 21, 1995, of GA transport encoder operation for certain tests related to video quality/auxiliary data tradeoff.
    - SSWP2-1462, Letter from T. Gurley (ATTC) to M. Richer (Chairman, SS/WP-2), dated July 25, 1995, regarding test results for upper-adjacent channel ATV-into-NTSC interference.
    - SSWP2-1464, Letter from T. Gurley (ATTC) to M. Richer (Chairman, SS/WP-2), dated July 25, 1995, concerning testing for degradation of BTSC audio.
    - SSWP2-1465, Letter from T. Gurley (ATTC) to M. Richer (Chairman, SS/WP-2), dated July 25, 1995, providing a description involving six of the 26 images used as the "reference" in the Basic Quality testing of the progressive format of the GA HDTV system.
    - SSWP2-1466, Letter from T. Smith (Sarnoff) to M. Richer (Chairman, SS/WP-2), dated July 24, 1995, concerning the comparability of the multiple copies of the digital HDTV GA prototype.

- Document from Lief Otto (Zenith) dated June 14, 1995, regarding 8 VSB Modem problem of June 14, 1995.
- Document from Lief Otto (Zenith) dated June 15, 1995, regarding 8 VSB Modem problem of June 15, 1995.
- Memo to File from C. Rhodes (ATTC) and G. Sgrignoli (Zenith), dated May 12, 1995, "Comparing Original and VSA Measurements of Grand Alliance HDTV System."
- Memo from Siu-Wai Wu (AT&T) to C. Rhodes (ATTC), dated June 19, 1995, regarding Step Response of the GA HDTV system.
- Memo from J. Mailhot (AT&T) to C. Rhodes (ATTC), dated June 28, 1995, regarding scene change detection in GA encoder.
- Letter from K. Challapali (Philips) to C. Rhodes (ATTC), dated July 21, 1995 regarding aberrations on a horizontal sweep signal observed on a waveform monitoring scope.

• Results of Offsite Viewing of Long-Form Entertainment Program

CERTIFICATIONS BY THE GRAND ALLIANCE TO ADVANCED TELEVISION TEST CENTER

CERTIFICATION OF GRAND ALLIANCE DIGITAL HDTV SYSTEM
UPON DELIVERY

The undersigned representative of the Grand Alliance members, who is duly authorized for this purpose, hereby warrants to Advanced Television Test Center, Inc. and Cable Television Laboratories, Inc., as required by the terms of the Grand Alliance System Testing Agreement, that the Digital HDTV System delivered by the Grand Alliance members to the Test Center for testing is the system that was accepted and approved by the FCC Advisory Committee on Advanced Television Service (Technical Subgroup) on December 7, 1994, and is described in "Grand Alliance HDTV System Specification: Version 2.0" (dated December 7, 1994). Any differences and/or exceptions are noted and initialed ~~below~~. on attached letter

Attachment (4/18 [illegible] ltr. Lynn T. Smith)

By: Richard Citta

Title: Manager System R&D

Date: 4-19-95

CERTIFICATION OF GRAND ALLIANCE DIGITAL HDTV SYSTEM
PRIOR TO TESTING

The undersigned representative of the Grand Alliance members, who is duly authorized for this purpose, hereby warrants to Advanced Television Test Center, Inc. and Cable Television Laboratories, Inc., as required by the terms of the Grand Alliance System Testing Agreement, that the Grand Alliance Digital HDTV System is operating in accordance with the "Grand Alliance HDTV System Specification: Version 2.0", submitted to the FCC Advisory Committee on Advanced Television Service (Technical Subgroup), on December 7, 1994, and that this system is ready for testing. Any differences and/or exceptions, including any parts of this system which are not ready for testing at this time, are noted and initialed ~~below.~~ Per attached letter

Attachment (4/18 memo and letter from T. Smith)

By: Richard Citta

Title: Manager System R&D.

Date: 4-19-95

ADVANCED TELEVISION TEST CENTER, INC.

1330 BRADDOCK PLACE · SUITE 200 · ALEXANDRIA, VIRGINIA 22314-1650
703/739-3850 FAX 703/739-3230

To: File

Subject: Completion of Tests

This certifies that authorized representatives of AT&T Corporation, David Sarnoff Research Center Corporation, General Instrument Corporation of Delaware, the Massachusetts Institute of Technology, Philips Electronics North America Corporation, Thomson Consumer Electronics, Inc., and Zenith Electronics Corporation, collectively the Grand Alliance Members, and the Advanced Television Test Center, Inc., have reviewed the test results and agree that all the tests, except those listed below*, contained in the "Grand Alliance System Test Procedures" (SSWP2-1036), dated March 24, 1995, as amended, were completed and satisfactorily recorded on the Grand Alliance HDTV System, as described to and approved by the Technical Subgroup of the FCC Advisory Committee on Advanced Television Service, in the document entitled "Grand Alliance HDTV System Specification, Version 2.0", dated December 7, 1994.

R M Rast
For Grand Alliance Members

21 July 1995
Date

For Advanced Television Test Center, Inc.

July 21, 1995
Date

*Exceptions:

- Henderson Task Force on Digital-Specific Testing viewing for quality comparison to first-round digital systems (Technical Subgroup, "Grand Alliance HDTV System Specification, Version 2.0", 12/7/94, Chapter 9)
- Expert listening for Effects of Concatenation on Audio Processing (Test Plan Section I-11)
- Interoperability and Packetization Tests (Test Plan Section 9)
  - 9.1 Switching Between Compressed Data Streams
  - 9.2 Header/Descriptor Robustness
  - 9.3 Compression Layer Interoperability (Video and Audio)
  - 9.4 Transport Layer Interoperability (MPEG Compliance Verification and Interoperability with ATM Networks)

EXAMPLE OF NTSC VOTING ANALYSIS